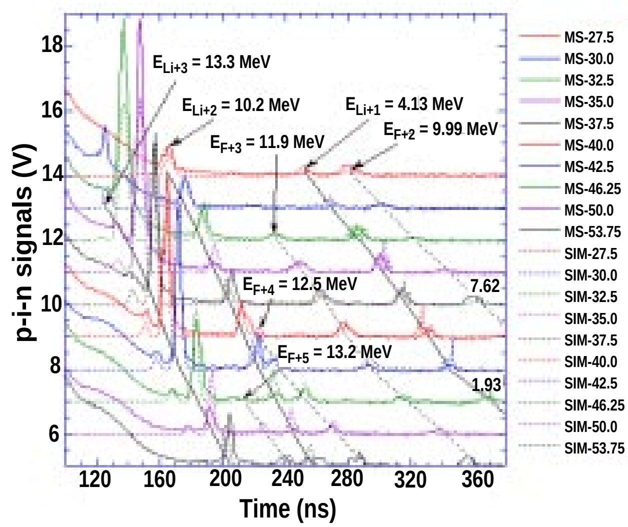
February 1996 Highlights of the Pulsed Power Inertial Confinement Fusion Program

The review of our pulsed power programs on February 21-22 emphasized contributions to science-based stockpile stewardship from z pinch and ion beam research. New spectrometer data in the extraction mode on PBFA II reinforce our decision to implement active lithium sources. We are testing a new spectroscopic diagnostic to measure electric and magnetic fields simultaneously in the diode gap, and we are evaluating commercial switches for the National Ignition Facility (NIF).



Measured (solid) and simulated (dashed) magnetic spectrometer signals for Li^{+1} and F^{+1} beams at 10 separate angles for PBFA-X shot no. 526. Initial pulses are from the 7.5% of Li^6 in the lithium beam.

For the first time, magnetic spectrometer data from the passive lithium fluoride source (see figure) have shown that the ion current in fluorine is a substantial fraction (about 25%) of the total ion current, nearly independent of cleaning or the current density level. We are seeking to understand the differences from the fluorine ion levels of about 5% measured on the PBFA-II radially-focusing diode and on the SABRE extraction diode. On the other hand, using better vacuums (2 x 10^{-6} torr) and RF glow discharge cleaning (at 1 - 1.5 kW powers, compared to 600 W with the radial diode), we see an increase by a factor of two to five in the diode impedance at peak ion power. These encouraging results in the extraction (PBFA-X) ion mode suggest the total lithium ion current will increase if we use (1) an active rather than a passive source, (2) subsurface cleaning, and (3) a heated anode. The Laser EVaporation Ion Source (LEVIS) is such an active source. It relies on a neodymium glass laser to evaporate neutrals from a lithium-rich surface and a dye laser, tuned to the first ionization state of lithium, to ionize lithium. We will use LEVIS on PBFA X after completing our evaluation of cleaning techniques with heated LiF anodes.

In two months we begin modifications to the 50-TW PBFA-II accelerator to enable z-pinch-driven implosions at a higher current (20 MA) than is possible with the 10-MA, 20-TW Saturn pulsed-power generator. These modifications (PBFA Z) will eventually allow us to evaluate the performance of centimeter-scale ICF targets that are indirectly driven by an energetic (1.5-MJ) x-ray source. This 1.5-MJ estimate is based on our z-pinch models and is four times the soft x-ray energy obtained in Saturn experiments. The soft x-rays are created by conversion of the axial current pulse into the kinetic energy of a magnetically-driven imploding plasma formed from an annular array of wires or from a cylindrical or annular gas shell.

With visible and vacuum ultraviolet spectroscopy, we have measured time-dependent electric fields, plasma expansion velocities, and azimuthal plasma uniformity in the anode-cathode gap. These state-of-the-art diagnostics have allowed us to compare experimental data with analytic theories and 3-D particle-in-cell simulations of ion diode behavior. We have developed an active spectroscopy probe (ASP) that uses laser induced fluorescence of a sodium tracer to measure electric and magnetic fields *simultaneously with subnanosecond time resolution and 3-D spatial resolution* within the gap. This new diagnostic will increase our ability to understand the physics of ion diode behavior and to improve models for the ion beam generation phase in electromagnetic particle-in-cell codes.

The NIF switch test stand is now operational. We are evaluating ignitron switches at several hundred kiloamperes. The commercial switch eventually selected for the NIF power conditioning system must be able to conduct a 24-kV, 500-kA, 360-µs pulse.

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Archived copies of the *Highlights* beginning July 1993 are available at http://www.sandia.gov/pulspowr/hedicf/highlights.